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BEFORE THE BOARD OF PATENT APPEALS

AND INTERFERENCES

Application Number: 10/608,091

Filing Date: June 30, 2003

Appellant(s): STEGER, ROBERT J.

Buchanan Ingersoll & Rooney PC

For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 9/25/08 appealing from the Office action mailed 01/25/08.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The following are the related appeals, interferences, and judicial proceedings known to the examiner which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal:

None.

(3) Status of Claims

The statement of the status of claims contained in the brief is not correct since withdrawn claims 13, 14, 24-29 and 31 are included in the claims being appealed.

A correct statement of the claims is as follows:

Claims on Appeal: 1-3, 5-12, 15-23, 32, 33

Claims Withdrawn From Consideration: 13, 14, 24-29 and 31

Claims Cancelled: 4, 30

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

The summary of claimed subject matter contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct. However, withdrawn claim 31 is repeated on page 9 of the Claim Appendix.

(8) Evidence Relied Upon

6,488,863	YATSUDA et al	12-2002
6,800,173	CHIANG et al	10-2004
6,529,686	RAMANAN et al	03-2003
2004/0163601	KADOTANI et al	08-2004
20010018828	KADOTANI	09-2001
6,635,580	YANG et al	10-2003
2001/0009178	TAMURA et al	07-2001
6,007,635	MAHAWILI	12-1999
7,022,616	MIMURA et al	04-2006
2002/0075624	WANG et al	06-2002

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 1, 2, 10, 12, 15, 16, 21 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686).

Regarding Claims 1, 2, 15, 16: Yatsuda et al teach a substrate support for plasma processing comprising:

a ceramic member 20;

a metallic heat transfer member 18 (made from aluminum) overlying the ceramic member 20 and including cooling flow passage 34 through which a coolant can be circulated to control temperature of the wafer W;

an electrostatic chuck 28 overlying the heat transfer member 18 and having a support surface for supporting a substrate W in a reaction chamber 16 of a plasma processing apparatus (column 3, lines 15-65). Though Yatsuda et al do not explicitly teach source of temperature controlled liquid, a coolant source would be obviously provided in the apparatus to enable supply the coolant through flow passage 34 to the heat transfer member 18.

Yatsuda et al teach a coolant is circulated through the heat transfer member but do not explicitly teach: a liquid coolant is circulated to heat and cool the heat transfer member, a source of temperature controlled liquid in flow communication with the at least one flow passage; and

a controller operable to control the volumetric flow rate and/or the temperature of the liquid circulated through the at least one flow passage, so as to control heating and cooling of the heat transfer member at a rate of from about 0.25-2°C/sec. Further, Yatsuda et al also do not teach the heat transfer member having a maximum thickness of about ¼ inch.

However use of liquid as a coolant for temperature controlled substrate holders for plasma processing apparatus is known in the art as per reference cited hereunder. Further, though Yatsuda et al do not explicitly disclose, the flow/temperature of coolant is normally controlled to obtain desired temperature control of the heat transfer member (would involve cooling as well as heating of the heat transfer member) as per reference cited hereunder.

Chiang et al teach a temperature controlled electrostatic chuck assembly comprising an electrostatic chuck assembly 6 and a heat transfer member 110 having coolant (water) flow passages 78. Chiang et al further teach a source of temperature controlled fluid 76 and controller 330 that is operable to control the volumetric rate flow rate and/or temperature of the coolant liquid so as to control heating and/or cooling of the substrate 8 (that is, also of the heat transfer member) [e.g. Figs. 27, 28 and col. 21, line 38 to col. 22, line 36].

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to provide a controller that is operable to control the volumetric rate flow rate and/or temperature of the coolant liquid circulated through coolant flow passage as taught by Chiang et al in the apparatus of Yatsuda et al to provide precise control of temperature of the heat transfer element.

Yatsuda et al in view of Chiang et al do not teach heat transfer member having a maximum thickness of about ¼ inch and the controller enables control of heating and cooling of heat transfer member at a rate of from 0.25 – 2 degrees C/sec. .

However, thickness of heat transfer member is related to its thermal mass and it would be obvious to select thickness of the heat transfer member to obtain a desired thermal response during processing of a substrate, as per reference cited hereunder.

Ramanan et al teach a wafer processing apparatus (Figures 1a-1c) comprising:

a low thermal mass conductive heating member 20 for heating a wafer 12 in a chamber 16. Ramanan et al further teach that the thickness and diameter of heating member are related to thermal mass of the heating member. Ramanan et al further teach that for efficient and rapid heating/cooling of a workpiece, the heating member should have low thermal mass and high thermal conductivity. Ramanan et al also teach that as an example, for a low thermal mass ceramic heating member with a diameter ranging from 8-13 inch, the thickness can be less than ½ inch and preferably from about 0.06 to 0.25 inch and having thermal mass varying from 500-2000 joules/C (col. 8, line 15 to col. 9, line 13). Thus thickness of heating member is a result effective variable that can be optimized to obtain a desired thermal mass, required as per process limitations. Though Ramanan et al do not explicitly teach metallic heating member (heat transfer member), his teaching could be applied to determine its optimum thickness as per process limitations like wafer size etc. Further, Ramanan also teaches that the controller can be agile enough to achieve the heating and cooling rates of 1 degree C/sec to 50 Degrees C/sec (as against claim limitation of 0.25- 2 degrees C/sec – which is a functional limitation) . It would be obvious to configure the controller to achieve the desired heating

and cooling rate as per process limitations like type of coolant, flow rate of coolant etc, in view of teaching of Ramaman et al and Chiang et al. Further, since the apparatus of prior art meets the structural limitations of the claim the same is considered capable of meeting the functional limitations.

In this connection courts have ruled:

1) "It is well settled that determination of optimum values of cause effective variables such as these process parameters is within the skill of one practicing in the art. *In re Boesch*, 205 USPQ 215 (CCPA 1980)."

2) Claims directed to apparatus must be distinguished from the prior art in terms of structure rather than function. *In re Danly*, 263 F.2d 844, 847, 120 USPQ 528, 531 (CCPA 1959). Apparatus claims cover what a device is, not what a device does *Hewlett-Packard Co. V. Bausch & Lomb Inc.,* 15USPQ2d 1525, 1528 (Fed. Cir. 1990)

Regarding Claims 10, 21: Yatsuda et al teach an RF power source 48 electrically connected to the worktable 18 (heat transfer member) through a lead line 44 {Figure 1}.

Regarding Claims 12, 23: Yatsuda et al discloses a plasma processing apparatus comprising the substrate support of Claim 1 (Fig. 1).

Claims 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Kadotani et al (US PGPUB No. 2004/0163601).

Regarding Claim 3: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim except coolant flow passage dimensions.

Kadotani et al teach an apparatus (Figures 1, 7) that includes a substrate support for supporting a wafer W and having an electrode block 1 (heat transfer member) with coolant flow passages 11, 12. Kadotani et al further teaches that dimensions of coolant passages are related to heat transfer from the coolant to the electrode block (heat transfer member). Thus coolant flow passage dimensions would be result effective variable that could be optimized for the requirede heat transfer rate as per process limitations like flow rate, type of coolant etc. Further, though Kadotani et al apparatus uses a heat transfer gas, his teachings could be used for optimizing flow passage dimensions where a liquid is used in place of gas coolant, since use of both gas and liquid coolants in plasma processing apparatus is known in the art [for example, paragraphs 0077].

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to control (optimize) coolant flow passage dimensions (result effective variable), as taught by Kadotani et al in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al for achieving required heat transfer rate between coolant and the heat transfer member, as per process limitations like type of coolant, coolant flow rate etc.

In this connection courts have ruled:

"It is well settled that determination of optimum values of cause effective variables such as these process parameters is within the skill of one practicing in the art. *In re Boesch*, 205 USPQ 215 (CCPA 1980)."

Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Kadotani et al (US PGPUB No. 2001/0018828).

Regarding Claim 5: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim except the source of temperature controlled liquid includes a Peltier cooler operable to change the temperature of the liquid to a selected temperature.

Kadotani et al teach an apparatus for fluid temperature control (Figure 1) for comprising:

A fluid passage 25 for flowing the fluid whose temperature is to be controlled (fluid can be water or ethylene glycol etc);

Cooling pipes 9 for flow of cooling liquid (water or refrigerant); and

Thermo-electric elements 7 (peltier elements) that absorb the heat from the fluid and discharge the same to cooling liquid (abstract and paragraphs 0040-0043, 0052).

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to use peltier (thermoelectric) devices as taught by Kadotani et al in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al for accurately controlling temperature of cooling liquid over a wide temperature range.

Claims 6, 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent

6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Yang et al (US 6,635,580).

Regarding Claims 6, 17: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim including a heat transfer gas source 52 operable to supply a heat transfer gas between the support surface and the substrate 8 (Chiang et al – Fig. 6), but do not teach the controller is operable to (i) control the flow rate and/or pressure of the heat transfer gas supplied between the support surface and the substrate.

Yang et al discloses an apparatus for wafer processing comprising a temperature control apparatus 60 that includes a substrate support 62 that supports a wafer 46, a heat transfer gas source 32 that supplies heat transfer gas between substrate support 62 and the substrate through inlet conduit 64, a MFC 34, a manometer for pressure sensing and a controller 80 that control the flow rate and pressure of the heat transfer gas source supplied between the support surface and the substrate (for example, Fig. 3 and col. 6, lines 25-50).

Therefore it would have been obvious to a person of ordinary skill in the art at the time of the invention to provide a heat transfer gas between the substrate support and the substrate and a controller operable to control pressure and flow rate of the heat transfer gas as taught by Yang et al in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al to efficiently control wafer temperature by using a feedback control system for controlling the supply of heat transfer gas.

Claims 7, 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent

6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Tamura et al (US PGPUB 2001/0009178).

Regarding Claims 7, 18: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim except the heat transfer member comprises a base including the at least one flow passage and a cover overlying the base.

Tamura et al teach a wafer holding device (Figure 9) comprising a heat transfer member 2 with liquid coolant flow passages 42 and where the heat transfer member can be made in two parts that is, a base 53 including at least a flow passage and a cover 52 overlying the base (for example, Figs. 9, 15 and para. 0100).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use a two-part heat transfer member having a base with at least a flow passage and an overlying cover as taught by Tamura et al in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al for ease of manufacturing by making in two parts, due to complex shape of the base having flow passages.

Claims 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Mahawili (US patent No. 6,007,635).

Regarding Claim 8: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim including ceramic member 20 includes a recessed surface and a flange, and the heat transfer member 18 is disposed on the recessed surface,

and further the electrostatic chuck 28 contacts the flange of the ceramic member 20 (Yatsuda et al – Figure 1).

Yatsuda et al in view of Chiang et al and Ramanan et al do not teach heat transfer member is laterally spaced from the flange and the thickness of ceramic member at the recessed surface is about 1-4 mm.

Though Yatsuda et al do not teach that worktable (heat transfer member) 18 is laterally spaced from the flange, but it would be obvious to provide such lateral spacing to allow for thermal expansion between the heat transfer member 18 (made from aluminum) and the ceramic member 20 at the high processing temperatures during wafer processing (examiner notes that appellant has not disclosed any criticality for such a gap). A supporting reference (by Mahawili) is also cited hereunder.

Mahawili teaches a substrate support apparatus (Fig. 1) that includes a heater housing 22 with a support surface 21 in which a platform 10 (heat transfer member) is seated. Mahawili further teaches that heater housing 22 and platform 10 could be made from dissimilar materials like ceramic and aluminum respectively. Mahawili also teaches that support surface 21 of heater housing 22 is sized to permit unrestrained thermal expansion of platform 10 (that is, platform 10 is spaced from ceramic heater housing). Mahawili additionally teaches that recess depth of support surface 21 is sized so that substrate when seated in platform 10 is flush with the upper surface 22b of heater housing 22 {column 4, line 1 to column 5, line 20}. Thus, it would be obvious to optimize the depth of recess can be optimized (like a result effective variable) as per process limitations, like wafer thickness.

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to provide a spacing between the heat transfer member and the ceramic member, and optimize ceramic member thickness at the recessed surface as taught by Mahawili in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al to allow for thermal expansion between the heat transfer member (metallic) and the ceramic member, as per process limitations.

In this connection courts have ruled:

"It is well settled that determination of optimum values of cause effective variables such as these process parameters is within the skill of one practicing in the art. *In re Boesch*, 205 USPQ 215 (CCPA 1980)."

Claims 9, 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Mimura et al (US Patent No. 7,022,616) and Tamura et al (US PGPUB 2001/0009178).

Regarding Claim 9: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim except a ceramic ring overlying the ceramic member and surrounding the heat transfer member and the electrostatic chuck, the heat transfer member being laterally spaced from the ceramic ring, the electrostatic chuck contacting the ceramic ring.

Mimura et al teach a plasma apparatus (Figure 1) comprising a ceramic ring 5 overlying an insulating member 3 (normally made from ceramic) and surrounding a

support table 2 (heat transfer member) and an electrostatic chuck 6 that is in contact with the ceramic ring 5 (e.g. Fig. 1 and col. 3, lines 5-65). Though Mimura et al do not explicitly teach the heat transfer member being laterally spaced from the ceramic ring, it would be obvious to provide such a clearance for thermal expansion considering the different coefficients of thermal expansion of the ceramic ring and the heat transfer member (made from metal), as per reference cited below (Tamura et al).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention use a ceramic ring that contacts and surrounds an electrostatic chuck as taught by Mimura et al in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al to enable shield the electrostatic chuck from deposition by the reaction products.

Tamura et al teach a wafer holding device (Figure 9) comprising a heat transfer member 2 with liquid coolant flow passages 42 and where the heat transfer member can be made in two parts (Figure 15) {that is, metallic member 52 with coolant passages 42 and a holding member 53} which can then be joined together. Tamura et al further teach use of liquid coolant for flowing through coolant passages 42 (Figures 9, 15) and a heat transfer gas source operable to supply a heat transfer gas between the support surface and the substrate. Tamura et al further teach a ceramic ring 36 (susceptor) overlying the ceramic member 40 and surrounding the heat transfer member 2 that is laterally spaced from the ceramic ring (e.g. Fig. 9 and para. 0081-0083).

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to provide a lateral spacing between the heat transfer member and the ceramic ring as taught by Tamura et al in the apparatus of Yatsuda et al in view of

Chiang et al, Ramanan et al and Mimura et al to provide for thermal expansion between heat transfer member and the ceramic ring during high temperatures encountered in plasma processing.

Claims 11, 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Wang et al (US PGPUB No. 2002/0075624).

Regarding Claims 11, 22: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim except the substrate support further comprising an elastomeric joint between the ceramic member and the heat transfer member, and an elastomeric joint between the heat transfer member and the electrostatic chuck.

Wang et al teach a plasma apparatus (Figures 1, 2, 6) comprising an electrostatic chuck assembly 55 that includes an electrostatic member 100 (electrostatic chuck) is bonded to base 175 (heat transfer member) by a ductile and compliant layer 250 (elastomeric joint). Wang et al also teach that base 175 is in turn bonded to support 190 (ceramic member) by a compliant and ductile material 295 (elastomeric joint) [paragraphs 0036, 0038, 0056, 0063, 0066].

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention use elastomeric joints for bonding ceramic member, electrostatic chuck and heat transfer member as taught by Wang et al in the apparatus of Yatsuda et al in

view of Chiang et al and Ramanan et al to absorb thermal stresses arising due to different thermal coefficients of expansion of the interfacing materials (paragraph 0056).

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claim 15 and further in view of Mahawili (US patent No. 6,007,635).

Regarding Claim 19: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claim including that ceramic member 20 includes a recessed surface and a flange, and the heat transfer member 18 is disposed on the recessed surface, and further the electrostatic chuck 28 contacts the flange of the ceramic member 20 (Yatsuda et al – Figure 1).

Yatsuda et al in view of Chiang et al and Ramanan et al do not teach heat transfer member is laterally spaced from the flange.

Though Yatsuda et al do not teach that worktable (heat transfer member) 18 is laterally spaced from the flange, but it would be obvious to do the same to allow for thermal expansion between the heat transfer member 18 (made from aluminum) and the ceramic member 20 at the high temperatures during wafer processing (examiner notes that appellant has not disclosed any criticality for such a gap). A supporting reference (by Mahawili) is also cited hereunder.

Mahawili teaches a substrate support apparatus (Figure 1) that includes a heater housing 22 with a support surface 21 in which a platform 10 (heat transfer member) is seated. Mahawili further teaches that heater housing 22 and platform could be made from

dissimilar materials like ceramic and aluminum respectively. Mahawili also teaches that support surface 21 of heater housing 22 is sized to permit unrestrained radial thermal expansion of platform 10 (that is, platform 10 is spaced from ceramic heater housing){column 4, line 1 to column 5, line 20}.

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to provide a spacing between heat transfer member and ceramic member as taught by Mahawili in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al to allow for thermal expansion between heat transfer member (metallic) and the ceramic member.

Claims 32, 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yatsuda et al (US Patent No. 6,488,863) in view of Chiang et al (US Patent 6,800,173) and Ramanan et al (US patent No. 6,529,686) as applied to claims 1, 2, 10, 12, 15, 16, 21 and 23 and further in view of Gaylord et al (US patent No. 5,849,076).

Regarding Claim 32, 33: Yatsuda et al in view of Chiang et al and Ramanan et al teach all limitations of the claims including that the controller 330 (in combination with flow controller 74) is operable to control the heating of heat transfer member 110 by controlling the temperature and flow rate of the liquid coolant flowing through flow passage 78 (e.g. Chiang et al – col. 22, lines 21-45). Further, Ramanan et al teach that the apparatus includes controllers that are agile enough to precisely and accurately control temperature of the workpiece through heating and cooling steps that would include temperature changes in steps and ramps (e.g. Figs. 6-9). Ramanan et al also teach that the controller is operable for heating or cooling rates of 1 degrees C/sec to 50 degrees C/sec.

Yatsuda et al in view of Chiang et al and Ramanan et al do not teach that controller is operable to circulate a liquid having a first temperature through the flow passage to control the temperature of the heat transfer member to a first temperature and also operable to circulate a liquid having a second temperature through the flow passage to control the temperature of the heat transfer member to a second temperature.

Gaylord et al teach a wafer processing apparatus comprising a liquid cooling system that circulates a temperature controlled liquid through a gas ring 18 with a coolant passage 84, for controlling its temperature. Gaylord et al further teach that the cooling system also includes a controller 90, a temperature sensor 92, a heat exchanger 76 and a coolant conduit loop 78 through which the coolant is circulated through passages 84 in the seal ring 18. Gaylord et al also teach that controller is able to control the temperature of coolant to first and second temperatures depending upon processing condition in the reactor (e.g. Figs. 1-3 and col. 5, line 50 to col. 7, line 40). It would be obvious to configure the controller in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al to circulate liquid coolant with first and second temperatures as taught by Gaylord et al so as to enable the heat transfer member achieve first and second temperatures.

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to provide a controller that is operable to circulate a liquid coolant having first and second temperatures as taught by Gaylord et al in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al to enable control temperature of heat transfer member as per process limitations.

(10) Response to Arguments:

B. Rejection Under 35 U.S.C. §103(a) Over Yatsuda, Chiang and Ramanan - Claims 1, 2, 10, 12, 15, 16, 21 and 23

2. The combination of Yatsuda, Chiang and Ramanan Does Not Disclose All Claim Features - the claim features of "metallic heat transfer member having a maximum thickness of about 1/, inch including at least one flow passage", and "heating is performed solely by the heat transfer member" are missing.

a. Missing Claim Feature of a Metallic Heat Transfer Member Having a Maximum Thickness of About 1/4 Inch Including at Least One Flow Passage

Appellant argues that Ramanan provides no disclosure or suggestion of a "metallic heat transfer member having a maximum thickness of about 1/8 inch including at least one flow passage," as recited in Claim 1.

Examiner responds that Yatsuda teaches a metallic heat transfer member 18 (made from aluminum) overlying the ceramic member 20 and including a cooling flow passage 34 through which a coolant can be circulated to control temperature of the wafer W and an electrostatic chuck 28 overlying the heat transfer member 18 and having a support surface for supporting a substrate W in a reaction chamber 16 of a plasma processing apparatus (column 3, lines 15-65). Further, it is common knowledge that thermal mass of a solid object is related to its heat capacity over a desired temperature range. This is corroborated by Ramanan et al who teach a wafer processing apparatus (Figures l a-l c) comprising a low thermal mass conductive heating member 20 for heating a wafer 12 in a chamber 16. Ramanan et al further teach that the thickness and diameter of the heating member are related to thermal mass of the heating member, and

that for efficient and rapid heating/cooling of a workpiece, the heating member should have low thermal mass and high thermal conductivity. Ramanan et al also teach that as an example, for a low thermal mass ceramic heating member with a diameter ranging from 8-13 inch, the thickness can be less than ½ inch and preferably from about 0.06 to 0.25 inch and having thermal mass varying from 500-2000 joules/C. Ramanan additionally teach that the thermal mass of a heating member is mostly due to its thermal conductive material, and that heating element portion of the heating member is only about 5% of the total thermal mass of the heat transfer member (heat transfer member) itself (col. 8, line 15 to col. 9, line 13). Thus thickness of heating member is a result effective variable that can be optimized to obtain a desired thermal mass, required as per process limitations like a desired heating/cooling rate of the heat transfer member. Though Ramanan et al do not explicitly teach metallic heating member (heat transfer member), it would be obvious to apply his teaching to determine optimum thickness of a metallic heat transfer member in the apparatus of Yatsuda, as per process limitations like desired heating/cooling rate and wafer size etc. Thus, Yatsuda in view of Ramanan teach claim 1 limitation "metallic heat transfer member having a maximum thickness of about 1/8 inch including at least one flow passage". Appeallant's further argument regarding Chiang using a cooling plate 110 and base plate 112 that are thermally massive structures, is not relevant since the above claim limitation is already taught by Yatsuda in view of Ramanan as explained above, and the Chiang reference is cited for a different limitation in claim 1 viz. "heating performed solely by the heat transfer member", as explained below.

b. Missing Claim Feature of Heating Performed Solely by the Heat Transfer Member

Appellant contends that Chiang provides no disclosure that heated fluid flows into coolant channels 78, since Chiang discloses that the temperature of a substrate can be modulated by heating or cooling electrostatic chuck (ESC) 6 (column 9, lines 48-49). To heat ESC 6, power is supplied to resistive heater 72; and to cool ESC 6, "fluid from a coolant supply 76 ... flows in a plurality of coolant channels 78" (column 9, lines 53-56). Thus, when the reference is considered in its entirety, Chiang's disclosure of "regulating the temperature and/or flow of fluid in coolant channels 78" provides no suggestion that "heating is performed solely by the heat transfer member," as recited in Claims 1 and 15.

Examiner responds that as per Chiang reference as cited in the office action [Figs. 27, 28 and col. 21, line 38 to col. 22, line 36] the apparatus comprises a temperature controlled electrostatic chuck assembly including an electrostatic chuck 6 that holds a substrate 8, and a heat transfer member 110 having coolant (water) flow passages 78. Chiang et al further teach that temperature control of the substrate 8 can be accomplished by heating and/or cooling through a control system 330 by regulating the temperature (which would include heating/cooling) and /or flow of fluid in coolant channel 78. Thus Yatsuda in view of Chiang and Ramanan teach claim 1 limitation viz. "heating performed solely by the heat transfer member".

3. <u>Ramanan Provides No Recognition that the Thickness of the Cooling Member is a Result-Effective Variable</u>

Appellant argues that Ramanan does not disclose that the thickness of cooling member 26 with cooling channels 28 can be varied between 0.06 and 0.25 inch, and as such, Ramanan does not recognize the thickness of metallic cooling member 26 to be a

result-effective variable and thus, the thickness of the claimed "metallic heat transfer member" cannot be considered a result-effective variable.

Examiner responds that Yatsuda teaches a metallic heat transfer member 18 (made from aluminum) overlying the ceramic member 20 and including a cooling flow passage 34 through which a coolant can be circulated to control temperature of the wafer W and an electrostatic chuck 28 overlying the heat transfer member 18 and having a support surface for supporting a substrate W in a reaction chamber 16 of a plasma processing apparatus (column 3, lines 15-65). Further, Ramanan et al teach a wafer processing apparatus (Figures l a-lc) comprising a low thermal mass conductive heating member 20 for heating a wafer 12 in a chamber 16. Further, it is common knowledge that thermal mass of a solid object is related to its heat capacity over a desired temperature range. This is corroborated by Ramanan et al who teach that the thickness and diameter of the heating member are related to thermal mass of the heating member and that for efficient and rapid heating/cooling of a workpiece, the heating member should have low thermal mass and high thermal conductivity. Ramanan also teach that in a heating member it is desirable to have low thermal mass (that is, its dimensions like thickness, diameter etc) combined with high thermal conductivity to facilitate rapid/cooling of a workpiece (col. 9, lines 5-12). Ramanan et al also teach that as an example, for a low thermal mass ceramic heating member with a diameter ranging from 8-13 inch, the thickness can be less than ½ inch and preferably from about 0.06 to 0.25 inch and having thermal mass varying from 500-2000 joules/C. Thus Ramanan clearly indicates the thickness of heat transfer member to be a result effective variable to obtain rapid heating/cooling of a workpiece. It would thus be obvious to optimize the thickness of the

heat transfer member in the apparatus of Yatsuda in view of Chiang and Ramanan to obtain rapid heating/cooling of the heat transfer member. Ramanan additionally teach that the thermal mass of a heating member is mostly due to its thermal conductive material, and that heating element portion of the heating member is only about 5% of the total thermal mass of the heat transfer member (heat transfer member) itself (col. 8, line 15 to col. 9, line 13). Thus even though a heat transfer member may include a resistive heating element, the effect of the resistive heating element on the thermal mass would be minimal, and the dominant effect on thermal mass would be due to the conductive material itself. Thus thickness of heating member is a result effective variable that can be optimized to obtain a desired thermal mass, required as per process limitations like a desired heating/cooling rate of the heat transfer member.

3. No Articulated Reasoning for the Combination of Yatsuda, Chiang and Ramanan

a. Thickness of Claimed Heat Transfer Member

The final Official Action cites Ramanan for the disclosure of bakeplate 20 having a thickness of 0.06 to 0.25 inch and contends that it would have been obvious to select a thickness of the claimed "heat transfer member" based on Ramanan's disclosure of bakeplate 20 (final Official Action at page 5, lines 16-25).

However, to the extent the final Official Action is relying on simple substitution of one known element combining prior art elements according to known methods to yield predictable results, M.P.E.P. § 2143 (B) states that the Examiner must articulate a finding that one of ordinary skill in the art could have substituted one known element for another,

and the results of the substitution would have been predictable. The final Official Action articulates no such finding.

Examiner responds that as explained above, as per teaching of Ramanan, the thickness of the heat transfer member is a result effective variable that could be optimized to obtain a desired thermal mass, and that the teaching of Ramanan could be applied to a metallic heat transfer member to optimize its thickness, as also indicated in the office action dt. 01/25/08.

i.Bakeplate of Ramanan is Heated by Resistive Heating and Cooled by a Thermally Massive Heat Sink

Appellant states that Ramanan discloses a bakeplate 20 having a thickness of 0.06 to 0.25 inch (column 8, lines 63-67), which holds semiconductor device 12, and includes "one or more heating elements ... preferably in the form of resistive heating element[s]" (emphasis added) (column 13, lines 43-45). From Ramanan, the heating or chilling rates are achieved by resistively heating bakeplate 20 (column 13, lines 43-52) or contacting it with "thermally massive heat sink" cooling member 26 (column 13, lines 59-66).

ii. Worktable of Yatsuda is a Cooling Plate

Appellant further states that Yatsuda discloses a thermally massive aluminum worktable 18 for a plasma etching apparatus 14 (column 3, lines 17-28; FIG. 1), in which worktable 18 supports semiconductor wafer W (column 3, lines 34-39). Cooling jacket passage 34 in worktable 18 maintains wafer W "at a predetermined temperature by causing a coolant to flow in the jacket 34" (column 3, lines 53-55). Yatsuda discloses that

the temperature of worktable 18 is set from -30°C to 30°C during processing (column 6, lines 19-21; lines 42-43).

iii. Predictable Results Lacking

Appellant contends that the final Official Action has made no finding that modifying aluminum worktable 18 of Yatsuda such that worktable 18 has a thickness 0.06 to 0.25 inch, as disclosed by Ramanan, would result in a predictable heating and cooling rates. Furthermore, the heating and cooling rates of Ramanan are achieved by a combination of a resistively heating bakeplate 20 (column 13, lines 43-52) and cooling bakeplate 20 by contacting it with "thermally massive heat sink" cooling member 26 (column 13, lines 59-66). However, the objective of worktable 18 of Yatsuda is to maintain wafer W at a predetermined temperature (column 3, lines 53- 55), rather than altering the temperature of wafer W. As such, merely modifying the thickness of worktable 18 of Yatsuda would have an unknown and unpredictable effect on heating and cooling rates.

Examiner responds that as indicated above, Ramanan's teaches that in a heating member it is desirable to have low thermal mass (that is, its dimensions like thickness, diameter etc) combined with high thermal conductivity to facilitate rapid/cooling of a workpiece. Further Ramanan also gives an example for a low thermal mass ceramic heating member with a diameter ranging from 8-13 inch, the thickness of which can be less than ½ inch and preferably from about 0.06 to 0.25 inch, and having thermal mass varying from 500-2000 joules/C. Ramanan additionally teach that the thermal mass of a heating member is mostly due to its thermal conductive material, and that heating element portion of the heating member is only about 5% of the total thermal mass of the heat transfer member (heat transfer member) itself (col. 8, line 15 to col. 9, line 13). Thus

even though a heat transfer member may include a resistive heating element, the effect of the resistive heating element on the thermal mass would be minimal, and the dominant effect on thermal mass would be due to the conductive material itself . It would thus be obvious to optimize the heat transfer member of Yatsuda in view of Chiang, as per teaching of Ramanan to obtain the predictable result of a desired heating/cooling rate to enable precise temperature control of the wafer. Thus as per teaching of Ramanan, the thickness of the heat transfer member is a result effective variable that could be optimized to obtain a desired thermal mass, and the teaching of Ramanan could be applied to a metallic heat transfer member (as used in Yatsuda) to optimize its thickness, as also indicated in the office action dt. 01/25/08.

b. <u>Claimed Controller</u>

<u>i) No Finding that Each element Merely Performs the Same function As it Does Separately</u>

Appellant argues that office action does not include finding to indicate that Each Element Merely Performs the Same Function As It Does Separately viz that the control system of Ramanan can function independently of low thermal mass bakeplate 20 and massive heat sink cooling member 26 to achieve heating or chilling rates of 1°C/second to 50°C/second.

Examiner responds that the office action indicates optimizing the thickness of the heat transfer member as a result effective variable to obtain a desired thermal mass as per process limitations, in view of teaching of Ramanan, to obtain desired heating/cooling rate. Further, Ramanan also teach that controller can be agile enough to enable

heating/chilling rates of 1 degree C/sec to 50 degrees C/sec. Thus the controller of Ramanan with heating /cooling rates of 1 degree C/sec to 50 degrees C/sec would be usable with an optimized thickness heat transfer member in the apparatus of Yatsuda in view of Ramanan and Chiang, in line with teaching of Ramanan to this effect (col. 4, lines 44-53).

ii. <u>No Findinq That One of Ordinary Skill in the Art Would Have Recognized that the Results of the Combination Were Predictable</u>

Appellant argues that the final Official Action has made no finding that configuring the control system 330 of Chiang or worktable 18 of Yatsuda with the control system of Ramanan would predictably result in heating or chilling rates between 1°C/second to 50°C/second.

Examiner responds that one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). In this case, Chiang reference is cited for its teaching pertaining to claim limitation "a controller operable to control the volumetric flow rate and/or the temperature of the liquid circulated through the at least one flow passage, so as to control heating and cooling of heat transfer member" and "wherein heating is performed solely by the heat transfer member". More specifically, Chiang et al teach a temperature controlled electrostatic chuck assembly comprising an electrostatic chuck 6 and a heat transfer member 110 having coolant (water) flow passages 78. Chiang et al further teach a source of temperature controlled fluid 76 and a controller 330 that is designed to control temperature of the substrate by heating and/or cooling, and is

operable to accomplish temperature control by regulating the temperature and/or flow of liquid in coolant channel 78. Further, since the controller taught by Chiang regulates the temperature of the cooling fluid, it would also include both heating and cooling the heat transfer member, as per process limitations. Thus Chiang teaches claim 1 limitation "a controller operable to control the volumetric flow rate and/or the temperature of the liquid circulated through the at least one flow passage so as to control heating and cooling of heat transfer member, which is related to the controller capability and it would be obvious to combine the controller taught by Chiang with the optimized thickness heat transfer member of Yatsuda and Ramanan, for obtaining predictable result of precise temperature control of the substrate.

Thus, Yatsuda in view of Chiang and Ramanan teach all limitations of claim 1 as explained above, and also of dependent claims 2, 10, 12, 16, 16, 21 and 23.

C. <u>Rejection Under 35 U.S.C. §103(a) Over Yatsuda, Chiang, Ramanan and Mahawili - Claim 8</u>

Appellant argues that Yatsuda teaches low temperature processing, and given the difference in construction of the apparatus of Yatsuda and Mahawili, the rejection of claim 8 for claim limitation "the heat transfer member is laterally spaced from the flange", is improper since office action contends that this claimed feature is suggested by Yatsuda "to allow for thermal expansion of the heat transfer member between the heat transfer between ... [worktable] 18 and the ceramic member 20 at the high processing temperatures during wafer processing".

Examiner responds that as noted in the office action, Yatsuda et al does not explicitly teach that worktable (heat transfer member) 18 is laterally spaced from the flange. However it would be obvious to provide such lateral spacing, as per cited reference by Mahawili, to allow for thermal expansion between the heat transfer member 18 (made from aluminum) and the ceramic member 20 at high processing temperatures encountered during plasma processing. Further, Yatsuda also teach that the invention is applicable to other configurations (where different temperatures would be encountered during processing). Further, it is also noted that the appellant has not disclosed any criticality for such a gap between the heat transfer member and the flange of the ceramic member. In the absence of any disclosed criticality it would be obvious to provide spacing between heat transfer member and the flange of the ceramic member, as per general engineering considerations of tolerances, type of materials involved and processing conditions.

4. <u>No Citation for the Claim Feature of the Ceramic Member Having a Thickness of From About 1-4 mm at the Recess Surface</u>

Appellant argues that the final Official Action has not identified any structure in Yatsuda, Chiang, Ramanan and Mahawili that corresponds to the claim feature of "the ceramic member has a thickness of from about 1-4 mm at the recessed surface."

Examiner responds that Mahawili teaches that recess depth of support surface 21 (related to thickness of recessed portion of the housing 22, and similar to the recessed portion in the claimed ceramic member) is sized so that substrate when seated in platform 10 is flush with the upper surface 22b of heater housing 22 {column 4, line 1 to column

5, line 20}. Thus, it would be obvious to optimize the depth of recess of the claimed ceramic member (like a result effective variable) as per process limitations, like wafer thickness. In view of above, Yatsuda, in view of Chiang, Ramanan and Mahawili teach all limitations of claim 8.

D. <u>Rejection Under 35 U.S.C. §103(a) Over Yatsuda, Chiang, Ramanan and Mahawili -Claim 19</u>

<u>Claim 19 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Yatsuda in view of Chiang and Ramanan and further in view of Mahawili (final Official Action at page 13, ¶5).</u>

Appellant argues that Yatsuda teaches low temperature processing, and given the difference in construction of the apparatus of Yatsuda and Mahawili, the rejection of claim 8 for claim limitation "the heat transfer member is laterally spaced from the flange", is improper since office action contends that this claimed feature is suggested by Yatsuda "to allow for thermal expansion of the heat transfer member between the heat transfer between ... [worktable] 18 and the ceramic member 20 at the high processing temperatures during wafer processing".

Examiner responds that as noted in the office action, Yatsuda et al does not explicitly teach that worktable (heat transfer member) 18 is laterally spaced from the flange. However it would be obvious to provide such lateral spacing, as per cited reference by Mahawili, to allow for thermal expansion between the heat transfer member 18 (made from aluminum) and the ceramic member 20 at high processing temperatures encountered during plasma processing. Further, Yatsuda also teach that the invention is

applicable to other configurations (where different temperatures would be encountered during processing). Further, it is also noted that the appellant has not disclosed any criticality for such a gap between the heat transfer member and the flange of the ceramic member.

Appellant further contends that given the differences in construction between Yatsuda (cooled by a cooling passage 34) and Mahawili (wherein platform 10 and housing 22 overlie a heater assembly 24), the final Official Action has provided no articulated reasoning for modifying worktable 18 of Yatsuda with Mahawili's disclosure to include the claim feature of "the heat transfer member ... laterally spaced from the flange."

Examiner responds that Mahawili reference is cited for its teaching pertaining to sizing of adjacent dissimilar metal components by providing radial gaps to allow for thermal expansion of dissimilar metals. In the absence of any disclosed criticality it would be obvious to provide spacing between heat transfer member and the flange of the ceramic member, as per general engineering considerations of tolerances, and type of materials and the processing conditions.

E. <u>Rejection Under 35 U.S.C. §103(a) Over Yatsuda, Chiang, Ramanan and Gaylord - Claims 32 and 33</u>

<u>Claims 32 and 33 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Yatsuda in view of Chiang and Ramanan and further in view Gaylord et al. (U.S. Patent No. 5,849,076) ("Gaylord")</u>

<u>2. No Citation for the Claim Feature of Heat Transfer Member is Ramped from the First Temperature to the Second Temperature or Changed Step-Wise from the First Temperature to the Second Temperature</u>

Appellant argues that The final Official Action has not identified any disclosure in Yatsuda, Chiang, Ramanan or Gaylord that corresponds to the claim feature of "wherein the temperature of the heat transfer member is (i) ramped from the first temperature to the second temperature, or (ii) changed step-wise from the first temperature to the second temperature".

<u>3. Missing Claim Feature of Circulatinq a Liquid Having a First Temperature and Circulating a Liquid Having a Second Temperature During Processing of the Substrate</u>

Appellant also contends that Gaylord provides no disclosure that cooling system 74 switches from a first temperature to a second temperature during operation of barrel reactor 11. "controller

Examiner responds that Gaylord et al teach a wafer processing apparatus comprising a liquid cooling system that circulates a temperature controlled liquid through a gas ring 18 with a coolant passage 84, for controlling its temperature. Gaylord et al further teach that the cooling system also includes a controller 90, a temperature sensor 92, a heat exchanger 76 and a coolant conduit loop 78 through which the coolant is circulated through passages 84 in the seal ring 18. Gaylord et al also teach that controller is able to control the temperature of coolant to first and second temperatures depending upon processing condition in the reactor (e.g. Figs. 1-3 and col. 5, line 50 to col. 7, line 40). Thus, Gaylord teaches that controller 90 can switch between circulating a cooling fluid having a first temperature to circulating the cooling fluid having a second

temperature, depending upon the signal received from the sensor 96, as per processing conditions inside the reactor. It would be obvious to configure the controller in the apparatus of Yatsuda et al in view of Chiang et al and Ramanan et al as per teaching of Gaylord, to circulate liquid coolant with first and second temperatures as taught by Gaylord et al so as to enable control the temperature of the heat transfer member to first and second temperatures (either by ramping or by step increase). Thus, Yatsuda et al in view of Chiang et al, Ramanan et al and Gaylord et al teach all limitations of claims 32, 33.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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